DOCKET FILE COPY ORIGINAL

EDX ENGINEERING, INC.

P.O. Box 1547 ■ Eugene, Oregon 97440 ■ Tel: [541] 345-0019 ■ Fax: [541] 345-8145

December 8, 1997

RECEIVED
DEC 9 1997
MAIL ROOM

Secretary, Federal Communications Commission
Office of the Secretary
Federal Communications Commission
Washington, D.C. 20554

Re: MM Docket No. 97-217
File No. RM-9060

Dear Sir:

You will find enclosed the original plus ten copies of the comments of EDX Engineering, Inc. in MM Docket No. 97-217, File No. RM-9060.

If you have any questions, please call.

Sincerely,

Harry R. Anderson, Ph.D., P.E.
President and CEO

Enclosures

0+10

Proposed Rulemaking No. RM-9060

MM Docket No. 97-217

Comments of EDX Engineering, Inc.

1. Introduction

The firm of EDX Engineering, Inc. was established in 1985 to develop and market software programs for performing coverage and interference analysis for a wide variety of wireless communication systems, including MDS and ITFS systems. EDX has provided software programs of this type to most of the major participants in the MDS industry, including American Telecasting, Inc., CAI Wireless Systems, Inc., Pacific Telesis, Hardin & Associates, and the FCC itself. Given our strong relationship with the MDS industry, and with our substantial academic and practical background in wireless and digital system design, EDX is particularly well-qualified to comment on the technical aspects of Proposed Rulemaking No. RM-9060 (hereafter referred to as PRM-9060 or the PRM).

First, we welcome the Commission's effort to modify the Rules to allow a much more flexible use of the MDS/ITFS spectrum. The recent unprecedented interest and activity in the PCS spectrum is ample evidence of the perceived need of the American public for a greater variety of low cost two-way wireless information delivery mechanisms. The greater potential for such services which would be provided under PRM-9060 is a valuable addition to the wireless service landscape. With the exceptions discussed below, in general we support adoption of the Rules in PRM-9060 as proposed.

Our primary concern with PRM-9060 involves several of the technical methods for calculating potential interference from response stations to neighboring systems using the same or adjacent spectrum. As explained in detail below, we find much of the proposed methodology both unnecessarily complicated and off the mark in terms of providing good estimates of potential interference. Our comments therefore focus on the proposed response station interference calculation methods as set forth in paragraphs 34 through 41 of PRM-9060. We note that in Paragraphs 40 through 43 the Commission recognizes the proposed interference calculation methodology may be overly complex and specifically invites the public to propose alternative techniques[1].

2. The PRM-9060 Response Station Interference Calculation Methodology

As noted in the PRM, the fundamental problem with calculating the interference from response stations is that their locations are not specifically known because they are not individually licensed. To address this problem, the PRM sets forth a method for establishing a uniform grid throughout the response service area (RSA), and then using hypothetical transmitters at those grid locations to calculate interference to neighboring systems (or, one could infer, within the same system for frequency re-use purposes). This approach has several shortcomings, as described below.

2.1. Problems with Defining an RSA

The method of calculating interference from response stations assumes that there is an established response service area (RSA) which could be defined by some geographic means or even using a simple radius from the RSA hub[2]. In practice, the RSA for a given hub will rarely be confined to the extent that it can be described by simple geographically defined polygons. EDX's experience with cellular systems shows that the area served by a given cell site (the analog to the RSA hub) is almost never uniform or contiguous. The service areas are highly non-uniform, dis-contiguous, and generally not amenable to simple definition by outlining them with geographic polygon shapes. The non-uniform nature of real RSA's is a result of varying signal propagation environments including terrain features, buildings, and trees. It is easy to envision a circumstance in which the best RSA hub to serve a given home is not necessarily the closest because the closest hub is obstructed from the home by intervening hills, buildings, or trees.

---

[1] PRM-9060, paragraph 43.
[2] PRM-9060, paragraph 34.

The problems with defining an RSA are further compounded in PRM-9060 by a definition of "Regions" within RSA's. Regions are meant to be areas of similar population density, and an iterative test for subdividing an RSA based on the population of zip codes is prescribed for establishing these regions. Each region would have associated with it a class of response station, the idea being that regions of similar density will require similar antenna heights and power levels. Regions are specifically required to be contiguous and not overlap.

Not only would RSA's and regions be difficult to establish as explained above, requiring geographical definitions of such areas imposes a major administrative burden on the Commission. Since these RSA and region definitions are an intrinsic part of the interference calculation, in order for the Commission or anyone else to check the results of such calculations the geographical definitions of all RSA's and regions would need to be saved in a database of some kind for all to access. While the numerical construction of such boundaries as strings of latitude/longitude pairs is straightforward, it still represents a considerable mass of data which must be maintained and kept accurate by the Commission.

2.2. Problems with Defining a Grid

Assuming one could geographically define the RSA, the PRM sets forth a convoluted method for determining the location of a hypothetical grid within the RSA. The method basically seeks to establish a suitably small grid point spacing by comparing field strength calculation results at a string of points 0.5 miles beyond the periphery of the RSA using hypothetical transmitters located at alternating grid location sets. If the difference in the field strength calculations from the alternating grid location sets is within 3 dB, the grid is considered to be "fine-grained enough" and therefore suitable for use in calculating composite interference from the randomly dispersed response stations.

This approach to establishing a grid is flawed in several ways. First, the field strength calculations used in making the comparison assume flat terrain resulting in line-of-sight propagation conditions. With this substantial assumption, finer grid spacing really will result from increasingly non-uniform

RSA boundaries. In reality, a finer grid spacing should be employed when the terrain is more non-uniform since it is terrain irregularity that will have the greatest impact on the strength of composite interference calculated at another location. By leaving out terrain, the proposed method fundamentally misses the most important criteria for establishing grid spacing[3].

The proposed method also does not establish a unique grid which can be readily replicated by others. One objective in promulgating engineering methodology is to establish techniques which can be understood, and results which can be reproduced by any engineer who is competent in the field. This objective is important so that engineers may review applications for neighboring systems to satisfy themselves that the interference calculations indeed demonstrate compliance with applicable Commission Rules. The proposed method for establishing grid spacing seeks a sufficiently small grid spacing, but not a single unique grid spacing. Obviously, once past the threshold of what is sufficiently small, any smaller grid spacing would also meet the test, thus giving the engineer discretion as to which sufficiently small grid spacing he or she wishes to use. With such discretion, it will sometimes be difficult to get consistent results from different engineers even though both used methods which complied with the Rules. The Commission should not adopt interference calculation methods which invite such arbitrary disagreements.

Finally, the approach for establishing a grid in the PRM is inherently an iterative approach. The process starts by guessing at a suitable grid spacing, performing the test calculations, and then evaluating the results. If the test criterion is met, the "first guess" spacing is used and the interference calculations go forward. If the test criterion is not met, a new guess at grid spacing is made, the test performed again,

---

[3] Setting grid spacing is essentially a sampling technique with the intent that calculations using the discrete samples be reasonably representative of the result which would be obtained if the entire space were considered. As with sampling signals, the more rapidly varying the signal, the more closely-spaced the samples must be to adequately represent the signal. Similarly, when spatially sampling an area to establish discrete locations for representative response transmitters, the more rapidly varying the terrain, the more closely spaced the samples must be to result in a good representation.

and the results once again evaluated. This "guess and guess again" approach is continued until the test criterion is met.

From a computational efficiency standpoint, such interative techniques are to be avoided unless they are the only way to solve an otherwise intractable problem. As described in the next section, for this circumstance, there is absolutely no reason to resort to such iterative methods.

2.3. Alternative Method for Establishing a Sample Grid

Although EDX proposes an interference calculation method which does not rely on a grid to represent response station signals, as detailed in Section 3 below, should the Commission decide to retain the concept of the grid there are much easier and more uniform ways to establish such a grid than the method in the PRM. The method we think most appropriate would be to establish grid points at uniform geographical spacings (i.e. every 30 seconds, 15 seconds, 5 seconds, etc.) aligned on the absolute worldwide latitude/longitude grid. The actual grid spacing employed (e.g., whether 30 seconds, 15 seconds, etc. were to be used) would be determined based on the total area inside the RSA and the terrain variation inside the RSA. The terrain variation or roughness could be established as the inter-decile (10% to 90%) terrain elevation difference for elevation points inside the RSA. The number of grid points (and hence, grid spacing) could be adjusted in relationship to the RSA area and terrain variation so that a reasonable sample number of grid locations, and hence hypothetical response station transmitters, would be employed in the interference calculations.

Finally, since establishing the grid spacing and position relies on two numbers (RSA and terrain variation) which can both be calculated in a single step, the problems of an inefficient iterative calculation are avoided.

Of course, this method for establishing a grid also requires a geographically-defined RSA boundary. It shares this particular weakness with the method in the PRM.

3. Alternative Method for Calculating Interference from Dispersed Response Stations

As noted above, we do not think that using a grid to establish representative locations for hypothetical response stations is a practical approach to calculating the potential for interference to neighboring systems, or within the same system for frequency re-use purposes. Establishing realistic RSA boundaries will be difficult, and having a grid of many response transmitters for every RSA (regardless of how the grid is established) will present a daunting calculation burden when attempting to find interference potential to a neighboring system.

3.1. PCS Interference Calculations Methods

The problem of how to represent the interference contribution from a geographically-dispersed set of transmitters is not new to this proceeding. In promulgating Part 24 Rules for the PCS service, the Commission was faced with deciding on a method for calculating interference to fixed, point-to-point incumbent microwave systems in the PCS band from fixed and mobile transmitters in the newly authorized PCS service. The architecture of PCS systems is similar to that contemplated by this PRM; that is, a cellular type of system layout with frequency re-use and general flexibility for the licensees to make use of their blocks of spectrum in whatever way they consider appropriate to the marketplace as long as no interference results to other PCS systems or incumbent microwave systems. Mobile PCS users are randomly dispersed throughout the PCS service territory as would be the response stations in a two-way MDS system. There are really only two distinctions between PCS "response stations" and MDS response stations as envisioned in the PRM: PCS response stations are mobile and use omni-directional antennas whereas MDS response stations are fixed and will generally employ directional antennas. Since the specific locations of response stations in either case are random and unknown, the fact that one is mobile and other is fixed is not important. The second distinction regarding antenna types is potentially important and will be addressed below.

The method for calculating potential PCS interference to fixed microwave links is set forth in Part 24, Subpart E, Appendix I. In essence, this method assumes that mobiles and portables operating in a cell can be represented by a single transmitter located at the cell base station location operating with a power equal to the power of individual mobiles or portables multiplied by the number of mobiles or portables associated with that base station.

Aggregating power from a number of response stations so that it can be represented by a single transmitter is also described in the PRM[4], but in this case the aggregation points are the grid intersections rather than the base station locations (MDS response hubs). The result is a vast number of representative transmitters at grid locations which are not efficiently or uniquely determined, as discussed in Section 2 above.

The fundamental question here is: "Can the interference potential of the dispersed response stations be adequately modeled using a single composite transmitter at the RSA hub, or is a dispersed set of composite transmitters at the grid points needed to adequately model potential interference?" The crux of this issue is the geographical extent of the RSA (cell).

Part 24, Subpart E, Appendix I addresses this issue in the italicized section entitled *Special Situations.* Here they suggest that cells be subdivided if a) the terrain elevation variation within the cell is greater that 2 to 1, and 2) cell extent subtends an angle of greater than 5 degrees from the victim microwave receiver. Both criteria are based on the recognition that the path loss from all parts of the cell may not be adequately represented by a single propagation path from the base station to the victim receiver if the terrain variations within the cell are large or there is the potential that the characteristics of the propagation paths from various parts of the cell to the victim microwave receiver are quite different. Notably, to apply these *Special Situation* methods the PCS Rules also rely on some geographical cell

---

[4] PRM-9060, paragraph 36.

definition as does the method in PRM-9060. Also, the *Special Situation* section provides no direction on how a cell is to be subdivided (the equivalent of choosing grid points in PRM-9060).

Despite these shortcomings, the Part 24 method is instructive and perhaps the best guide on how aggregate interference from randomly dispersed response stations might be adequately considered without the complexity, ambiguity, and calculation burden of the method currently set forth in PRM-9060.

3.2. Recommended Method for Creating Aggregate Response Station Transmitters for Interference Calculation Purposes

It is recommended that the method for aggregating response station signals for the purposes of calculating interference as set forth in PRM-9060 be abandoned entirely. It is too complicated, imposes significant database maintenance and computational burdens on the Commission and licensees, and is largely misdirected in terms of how grid spacing is established. If this level of effort were justified, in some ways it would be just as easy to simply store the latitude/longitude location of every response station along with its specific transmitter and antenna/mast equipment. Modern GIS software make it a straightforward task to translate addresses into geographical coordinates, and presumably every licensee will maintain a database of addresses for all their subscribers. Of course, considering every response station in an interference calculation would exacerbate the computational burden.

Instead we recommend that a rational, pragmatic approach be taken to the response station interference issue. Following the general method in the Part 24 PCS Rules, we recommend that a single hypothetical aggregate response station be located at the RSA hub location, using an omni-directional antenna, and with power level set as a function of the maximum power level and number of response stations associated with that RSA hub. An omni-directional radiator is appropriate if one assumes the response stations are uniformly distributed around the RSA hub with their antennas pointed toward the hub.

This approach has several advantages:

1. The RSA hub location is known because it's part of the authorization like the main station and boosters.

2. The number of RSA hubs should be a tractable number in terms of computational burden. If the architecture of these MDS/ITFS systems follows cellular system layouts, it is rare to find a cellular or PCS system with more than several hundred cells, even when separate cell site sectors are considered as independent cells.

3. Since the interference calculation is based solely on the RSA hub location, it is unnecessary to develop geographical descriptions of RSA and region boundaries. This saves both engineering effort and the database resources to store and maintain this geographic information.

4. Because all the information needed to perform an interference calculation is part of the system authorization, such interference calculations can be readily checked by other engineers or by the Commission.

Of course, there is also a drawback to this approach; mainly, that the path loss from the RSA hub location to the area where the interference level is being calculated may not be indicative of path loss from where the response stations are actually located, or the path loss calculated for the many grid locations which would be established to represent the response stations in the current PRM-9060 method. The RSA hub may be obstructed by a hill, but likely, the RSA hub would be in an elevated position so that it can achieve line-of-sight propagation conditions to the response stations which it receives. Therefore, it is more likely that the path loss from the RSA hub in any direction would be lower than for the actual response stations, usually resulting in a conservative overestimate of interference rather than an underestimate of interference.

3.3. Tests of the Recommended Method for Creating Aggregate Response Station Transmitters

Two studies were conducted to test the hypothesis that the combined interference effect of randomly located response stations could be reasonably represented by a single equivalent transmitter located at the RSA hub. The first test assumed flat terrain and free space path loss. The second test used hypothetical response stations randomly located in San Francisco to gauge the impact of varying terrain on the validity of the hypothesis. In most real MDS or ITFS systems, the actual terrain will lie somewhere between these extremes.

3.3.1. Flat Terrain Equivalent RSA Interference Test

For the flat terrain test, circular RSA's with radii ranges from 1.0 to 20.0 kilometers were used. A number of response stations were located within the RSA under test using uniform random distributions of azimuth and distance from the RSA center. Once a response station location was established, it was assigned an antenna pointing angle such that its directional antenna was always pointed at the hub center regardless of where the response station was located within the RSA. It was assumed that each response station was equipped with a standard 20 dBi gain antenna with pattern envelope given by Figure 1, Section 21.903(f)(3) of the FCC Rules.

To evaluate the interference potential from the collection of response stations, the composite received signal level power from all response stations was calculated every degree from 0 to 359 degrees around the RSA center at a radius of 50 kilometers. This is representative of the method used to find interference at a nearby neighboring MDS systems.

For each RSA radius, random groups of 100, 1,000, and 10,000 response stations were positioned and the resulting composite interference signal power evaluated along the 50 km circle as described. The results of these tests are shown in Table 1. The table shows the various test cell radii and the number of response stations (RS's) for each test. The "Min. Power" and "Max. Power" values are the minimum and maximum received power levels found from the power calculations every degree on the 50 km radius reception circle. The "Ave. Power" column is the average power of those 360 values found by first converting the dBW values to Watts, summing and dividing by 360, then converting back to dBW.

The results show the expected consistency - as the number of response stations increases by a factor of 10, the average power increases by 10 dB. It is also interesting to note the relatively small range of variation around the circle even for as few as 100 transmitters. The greatest minimum-maximum

Table 1				
RSA radius	Number of RS's	Min. Power (dBW)	Max. Power (dBW)	Ave. Power (dBW)
1.0 km	100	-112.9	-106.6	-109.2
1.0	1,000	-100.0	-98.5	-99.2
1.0	10,000	-89.4	-89.0	-89.2
2.5	100	-111.7	-107.3	-109.3
2.5	1,000	-100.5	-98.4	-99.3
2.5	10,000	-89.6	-89.0	-89.3
5.0	100	-113.0	-107.3	-109.4
5.0	1,000	-100.4	-98.3	-99.4
5.0	10,000	-89.7	-89.0	-89.4
10.0	100	-113.3	-106.5	-109.8
10.0	1,000	-100.4	-99.0	-99.7
10.0	10,000	-90.1	-89.5	-89.7
20.0	100	-114.1	-108.2	-110.2
20.0	1,000	-101.3	-99.6	-100.3
20.0	10,000	-90.6	-90.0	-90.3

difference is only about 6 dB. This small difference indicates that a omni-directional antenna located at the RSA center with appropriately adjusted aggregate power could be a good representation of the combined interference effect of the actual response stations. A further review of Table 1 leads to the simple formula:

$$ERP_{hub} = ERP_{RS} + 10.0\,(\log_{10}(nrs) - 1.0) - 3.0 \text{ dBW} \qquad (1)$$

Where:

ERP_{hub} = the equivalent omni-directional hub power level (ERPi)
ERP_{RS} = the standard maximum response station ERPi (18 dBW) as set forth in PRM-9060
nrs = the number of response stations associated with that hub

Using the minimum and maximum values in Table 1, the random distribution of response stations could be replaced with a single omni-directional response station at the RSA center using a power level given by equation (1) with less than 4 dB difference in any direction at a distance of 50 km.

While the simple flat earth circular RSA example given above is useful for setting the appropriate equivalent hub power level, and it is directly applicable to relatively flat terrain situations, it ignores the important issue of how different propagation paths over varying terrain may be represented by a single path from the RSA hub. Also, the RSA hub in the above example was assumed to be located at the geometric center of the response station distribution. Although it's likely the RSA hub will be near the center, occasions will certainly arise where the RSA hub is asymmetrically located with respect to the response station distribution.

3.3.2. San Francisco Equivalent RSA Interference Tests

The second test was designed to address the issue of different propagation paths due to terrain. For this test, two hypothetical RSA's were devised in the San Francisco area. The San Francisco Bay area is well-known for its variable terrain when compared to other major metropolitan areas. It therefore represents a demanding test for the hypothesis that a single hub transmitter can be used to represent the aggregate interference potential of multiple response stations.

The first RSA was constructed with a hub located on Mt. Sutro, a very elevated location where most television broadcasters have built their transmitting facilities. The RSA was assumed to be circular with a five kilometer radius. Within the radius 100 response stations were randomly positioned. For each response station, the site elevation was set at the actual ground elevation for that random location (as taken from the terrain database) and the standard MDS 20 dBi gain antenna positioned 10 meters above ground. Each antenna was oriented toward the hub location on Mt. Sutro. Each response station was assumed to have a maximum ERPi of 18 dBW.

Figure 1 shows the areas within 50 km where the received signal level is above and below -103 dBmW. Figure 2 shows the same coverage levels for a single omni-directional transmitter at the hub location using a power level given by equation (1). The coverage in Figure 2 is clearly greater than that in Figure 1, indicating that the power level and/or antenna elevation are too high. Since the hub antenna location is much higher than the average antenna elevation of the response stations, this effect can to some extent be corrected by using a power de-rating on equation (1) based on the hub's height above terrain. Using average terrain elevation along 72 radials, within 5 km of the hub, and a power de-rating of 1 dBW for each 10 meters the hub is above the average terrain for the RSA, the equivalent hub power is lowered to about 0 dBW. Figure 3 shows the coverage for the omni-directional hub using this power.

The result is reasonably comparable to Figure 1 representing the signals from the random ensemble of response stations. When it is recognized that modern propagation models typically have prediction errors with a standard deviation of 10 dB or more[5], the equivalent hub interference could be considered nearly as valid an indication of real interference as is the composite 100 response station interference.

A second RSA was also tested to further explore this concept. The hub in this case was located in the northwest section of San Francisco at a much lower elevation than Mt. Sutro. The RSA was once again set as a circle but with a radius of 2.5 kilometers. The 100 response stations were randomly positioned inside this circle, with antenna elevations and orientations set as before. Figure 4 shows the signal level map for this ensemble of response stations. Figures 5 and 6 show the signal level maps for the equivalent omni-directional hub using the equation (1) power and the power de-rating based on hub height above average terrain, respectively. Again, the signal levels for the omni-directional hub with the de-rated power are comparable to the signal levels for the group of response stations shown in Figure 4.

Of course, the most dramatic difference in signal levels occurs in areas where the hub station is line-of-sight and no response stations are line-of-sight, or vice versa. Equivalent hub power adjustments alone cannot overcome this kind of difference since it is spatially dependent.

4. Conclusions

EDX generally supports the rule changes set forth in PRM-9060. However, we believe the interference study methods proposed for predicting response station interference are much more complicated than necessary or practical. As discussed in detail, the grid layout procedure is cumbersome, misdirected, and does not result in a unique, reproducible grid structure. Interference studies using arrays of response stations based on such grids will require considerable computation time,

---

[5] H.R. Anderson. "New 2D Physical EM Propagation Model Selected", *IEEE Vehicular Technology Society News*, Vol. 44, No. 3, August, 1997, pp. 15-22.

which will delay processing and review of proposed system configurations for possible interference conflicts.

An alternate, simplified technique for modeling aggregate response station interference was presented here. The included engineering studies show that for flat terrain, a single omni-directional hub can provide signal level predictions which match those for large numbers of response stations within a few dB. For highly variable terrain, the equivalent omni-directional response station approach is still effective if the hub power is de-rated to take into account its relative height above average terrain elevation in the RSA.

The Commission is urged to abandon the response station interference prediction method currently in PRM-9060 and replace it with the simplified "equivalent omni-directional hub" method presented here.

Respectfully submitted,

December 8, 1997

Harry R. Anderson, Ph.D., P.E.
President and CEO
EDX Engineering, Inc.

Affidavit

State of Oregon	)	
	)	ss.
Lane County	)	

I, Harry R. Anderson, depose and state that:

1. I am a qualified engineer and President of EDX Engineering, Inc., with offices located in Eugene, Oregon,
2. I received a Bachelor of Science degree in Electrical Engineering from the University of California, Santa Barbara, a Master of Science degree in Electrical and Computer Engineering from Oregon State University, and a Ph.D. degree in Electrical Engineering from the University of Bristol, Great Britain,
3. I am a registered professional engineer in the States of Oregon and California,
4. I have conducted engineering studies related to interference calculation methods applicable to proposed Rules in FCC MM Docket No. 97-217, File No. RM-9060,
5. The results of those studies are attached hereto and form a part of this affidavit.

Dated: December 8, 1997

Harry R. Anderson, Ph.D., P.E.

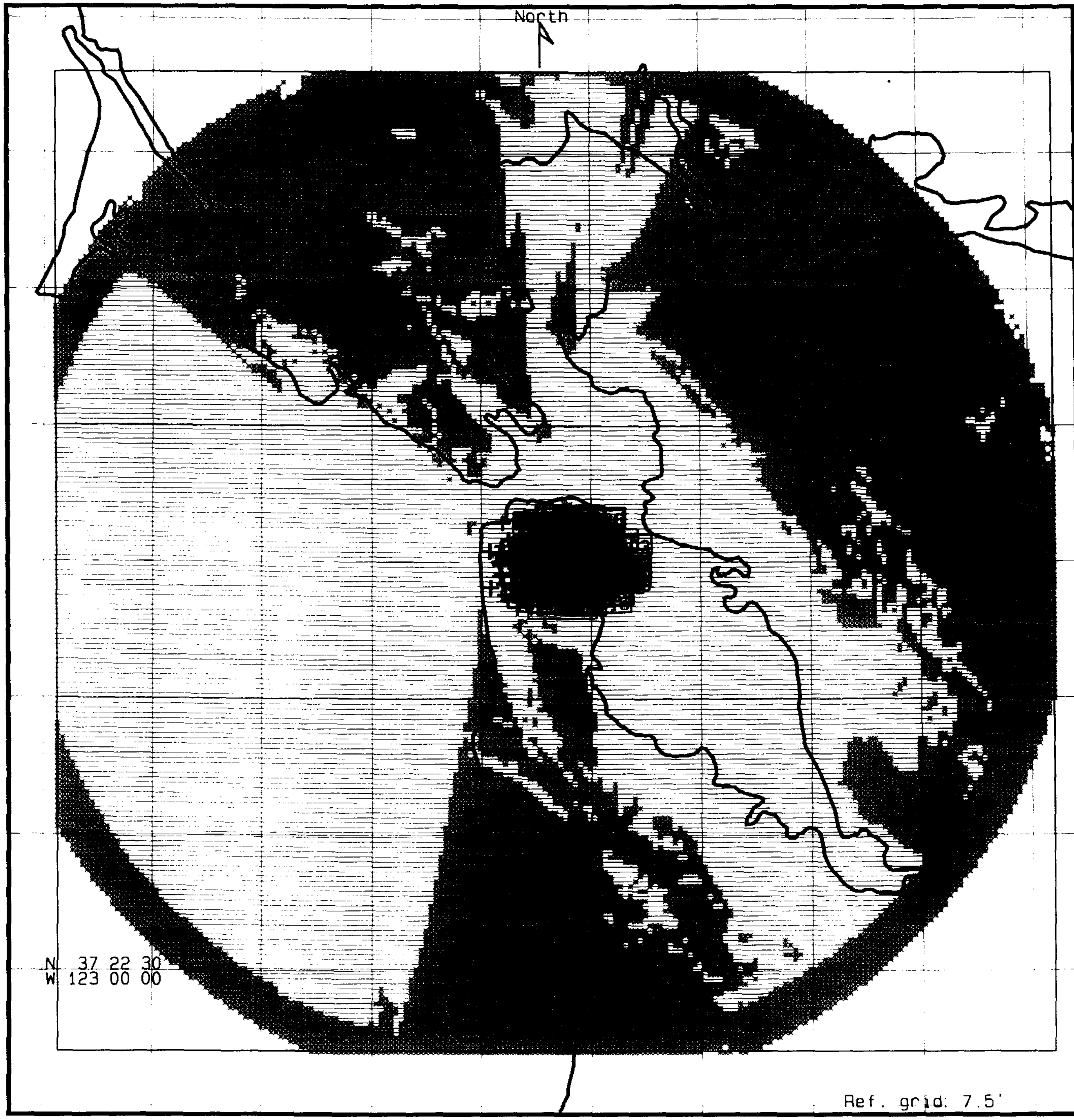
This 8th day of December, 1997, before me personally came the above-named Harry R. Anderson, who executed the foregoing Affidavit in my presence, and who acknowledges to me that he executed the same of his own free will for the purposes set forth herein.

OFFICIAL SEAL
SHANNON L MC KINLEY
NOTARY PUBLIC - OREGON
COMMISSION NO. 035130
MY COMMISSION EXPIRES AUG. 24, 1998

Shannon L. McKinley
Notary Public for Oregon

My Commission expires: August 24 1998

[SEAL]



SIGNAL (tm): mds_rm1.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
hra001 *	279.9	15.90	DA-V	N 37 45 .00
grp: 1	2600.0000 MHz		254.5	W122 26 50.99
hra002	84.9	15.90	DA-V	N 37 46 15.64
grp: 1	2600.0000 MHz		141.0	W122 28 8.55
hra003	25.1	15.90	DA-V	N 37 45 57.94
grp: 1	2600.0000 MHz		248.3	W122 23 46.81
hra004	70.0	15.90	DA-V	N 37 43 53.16
grp: 1	2600.0000 MHz		323.3	W122 25 47.97
hra005	135.3	15.90	DA-V	N 37 44 58.26
grp: 1	2600.0000 MHz		87.7	W122 27 44.79
hra006	199.2	15.90	DA-V	N 37 44 46.53
grp: 1	2600.0000 MHz		21.7	W122 26 57.79

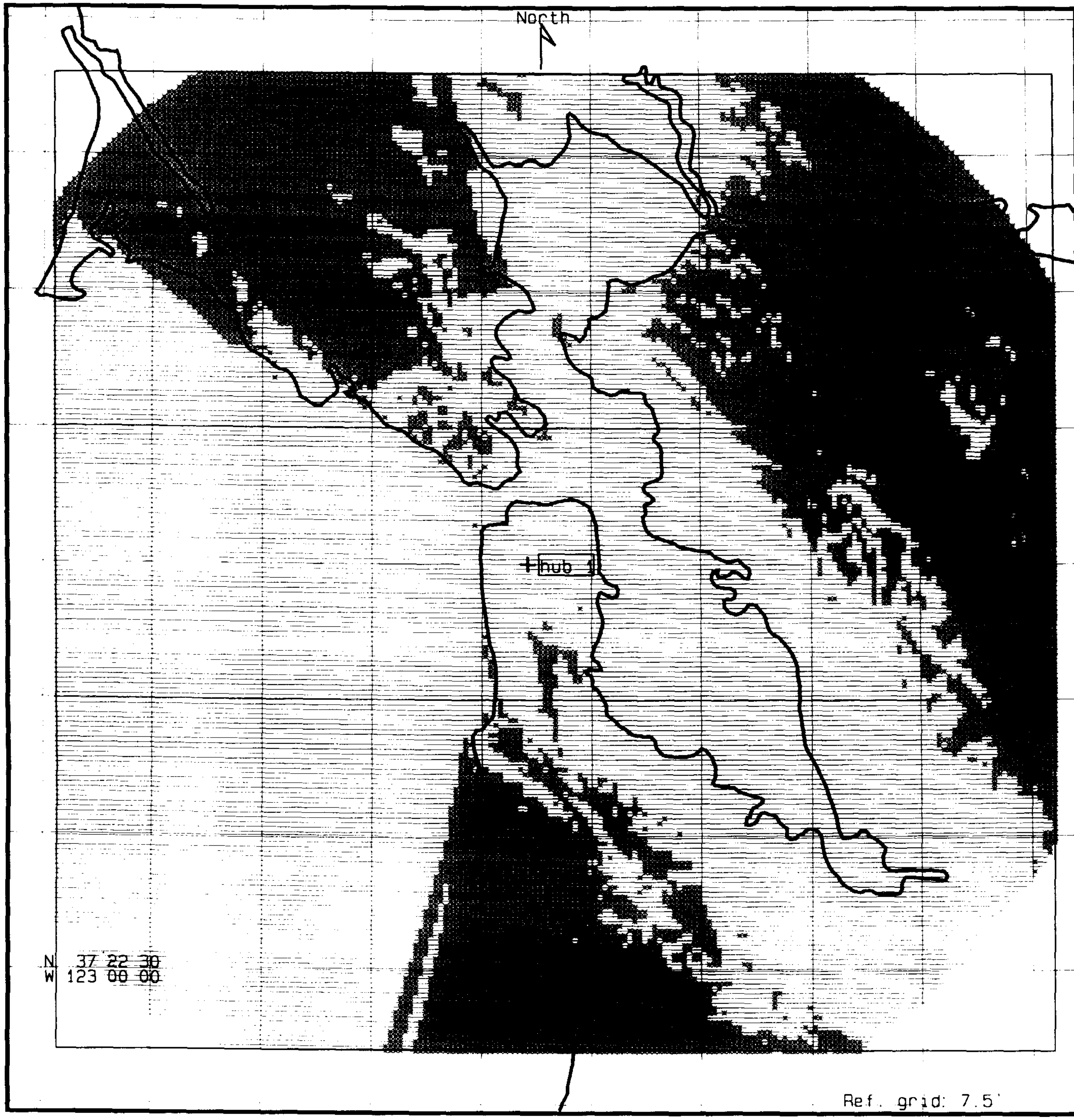
Not enough room for sites - see TX_SITE.LOG

KILOMETERS
10 0 10 20 30

TEST RS INTERFERENCE

100 randomly-located RSs

Figure 1 971130



SIGNAL (tm):mds_rm2.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

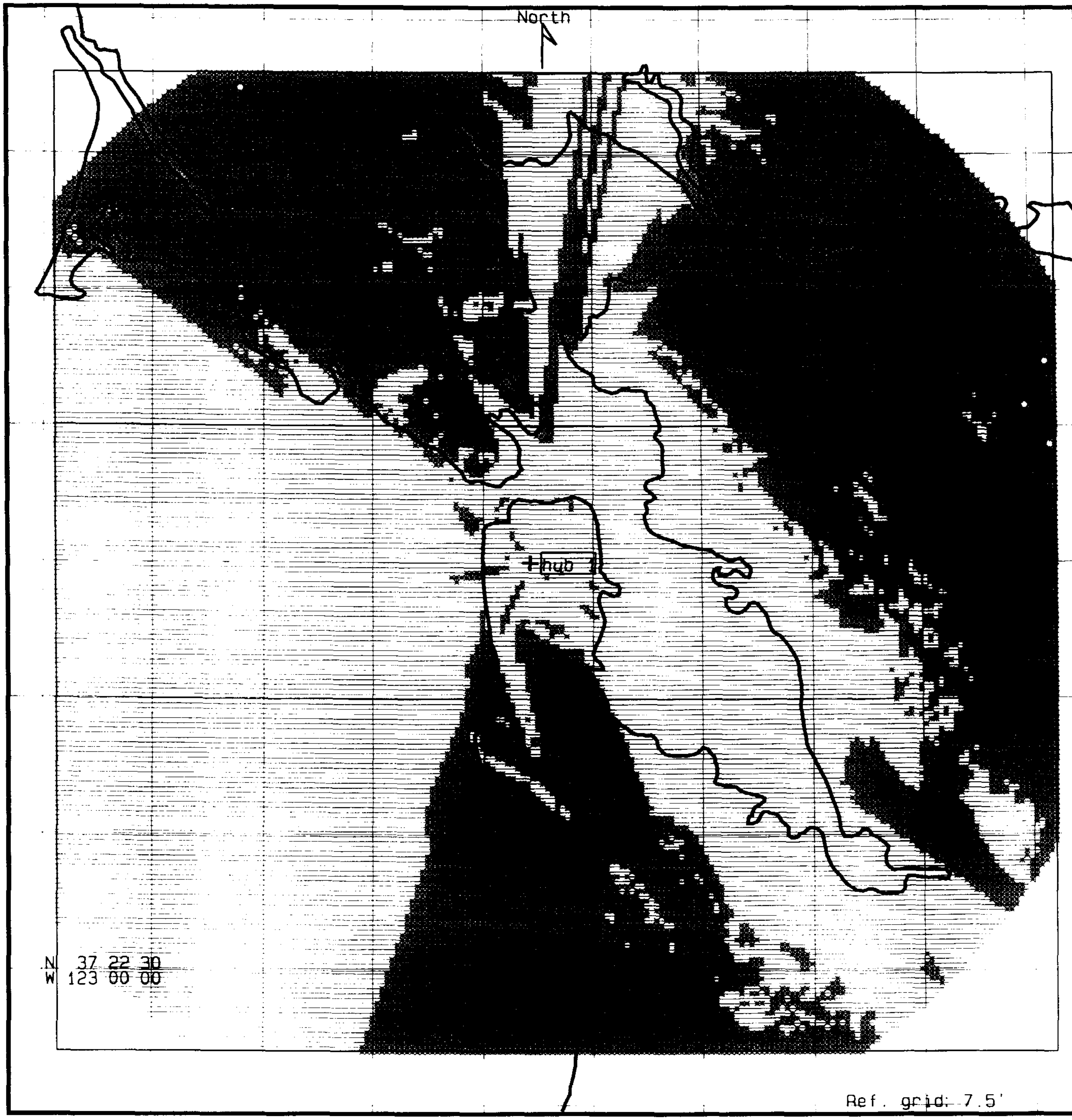
Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
hub_1	* 280.0	23.50	OM-V	N 37 45 .00
grp: 2	2600.0000 MHz			W122 26 51.00

KILOMETERS
10 0 10 20 30

TEST RS INTERFERENCE

Equivalent omni-directional hub

Figure 2 971130



SIGNAL (tm):mds_rm2.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

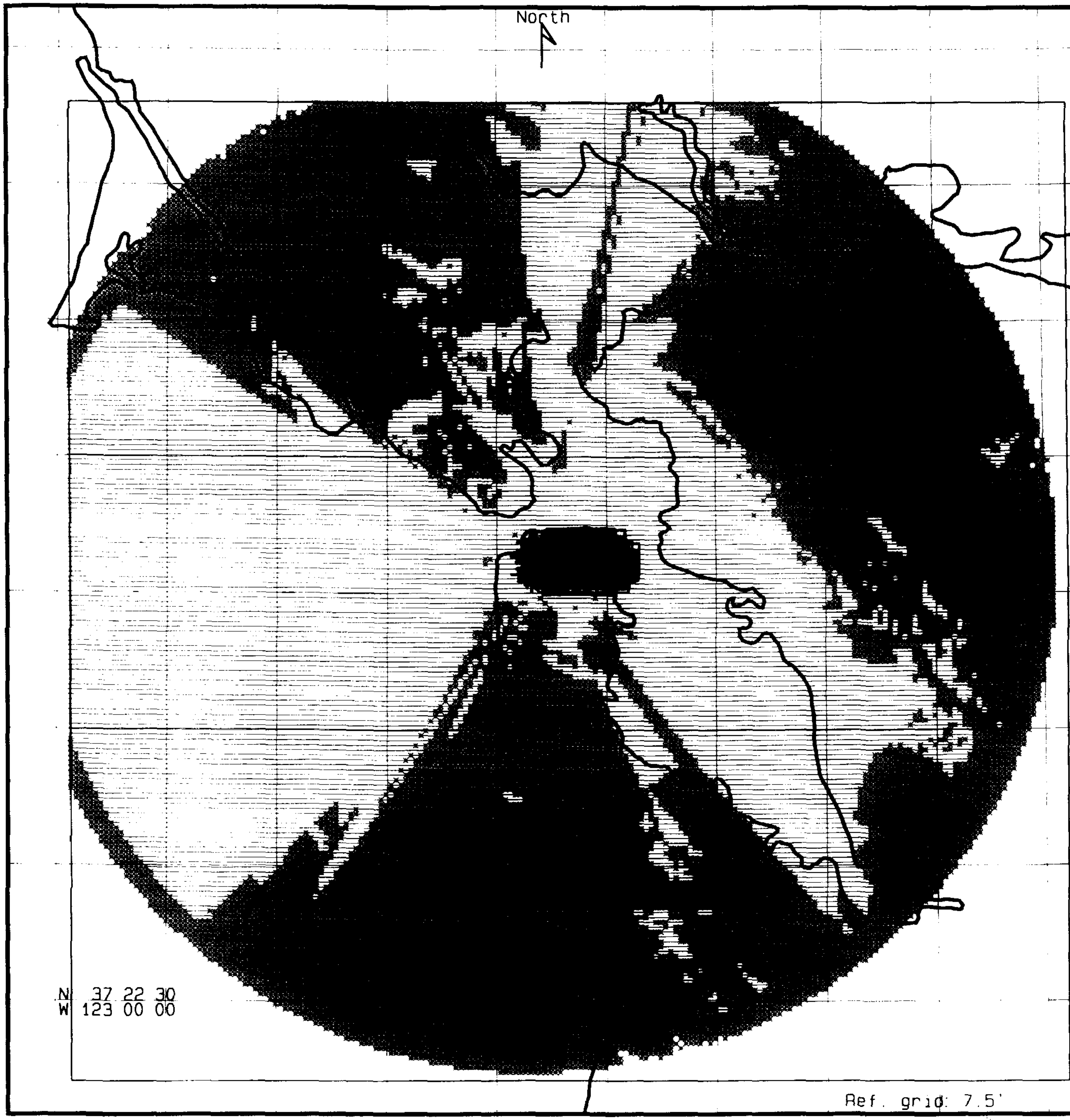
Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
hub_1	* 280.0	.00	OM-V	N 37 45 .00
grp: 2	2600.0000 MHz			W122 26 51.00

KILOMETERS
10 0 10 20 30

TEST RS INTERFERENCE

Equivalent omni-directional hub

Figure 3 971130



SIGNAL (tm):mds_rm4.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
bbb001 *	120.5	15.90	DA-V	N 37 46 44.04
grp: 1	2600.0000 MHz		264.4	W122 27 16.26
bbb002	70.0	15.90	DA-V	N 37 47 21.86
grp: 1	2600.0000 MHz		141.0	W122 27 55.06
bbb003	70.0	15.90	DA-V	N 37 47 13.02
grp: 1	2600.0000 MHz		248.3	W122 25 44.15
bbb004	114.2	15.90	DA-V	N 37 46 10.62
grp: 1	2600.0000 MHz		323.3	W122 26 44.74
bbb005	70.0	15.90	DA-V	N 37 46 43.17
grp: 1	2600.0000 MHz		87.7	W122 27 43.18
bbb006	116.2	15.90	DA-V	N 37 46 37.31
grp: 1	2600.0000 MHz		21.7	W122 27 19.67

Not enough room for sites - see TX_SITE.LOG

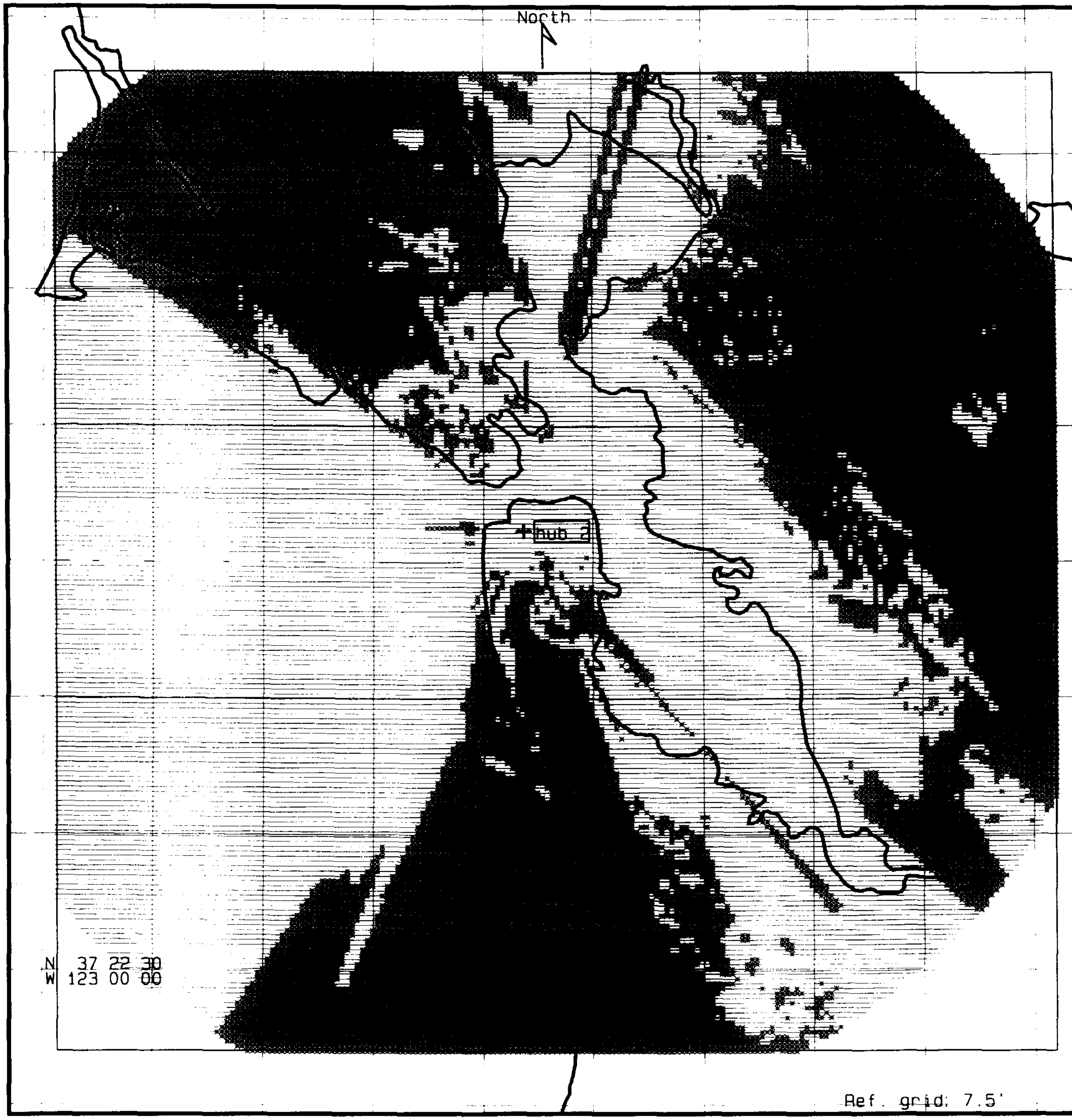
KILOMETERS

10 0 10 20 30

TEST RS INTERFERENCE

100 randomly-located RSs

Figure 4 971130



SIGNAL (tm):mds_rm3.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

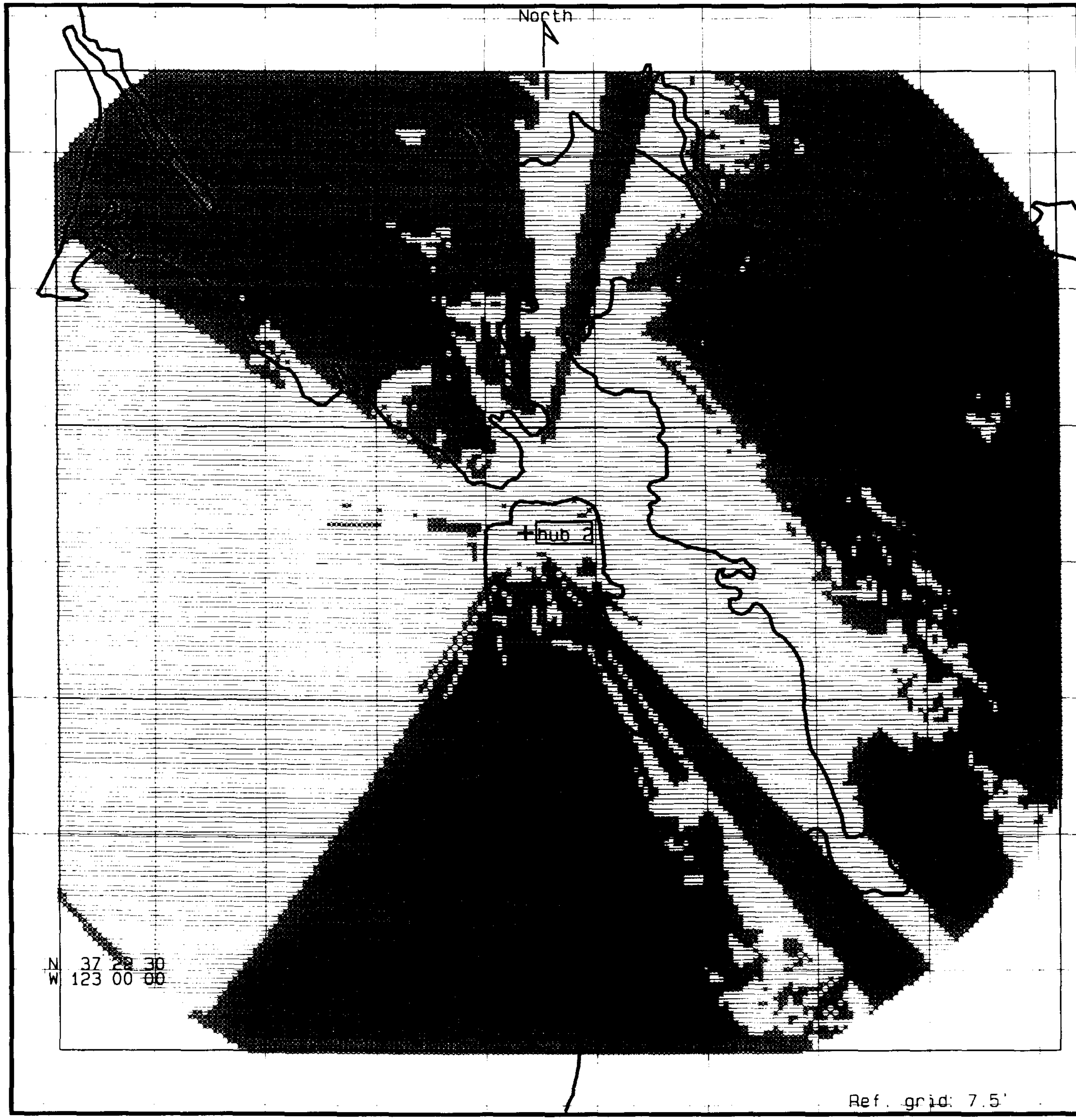
Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
hub_2	* 120.3	23.50	OM-V	N 37 46 44.20
grp: 2	2600.0000 MHz			W122 27 16.30

KILOMETERS
10 0 10 20 30

TEST RS INTERFERENCE

Equivalent omni-directional hub

Figure 5 971130



SIGNAL (tm): mds_rm3.map

Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 10.0 mtrs AGL Gain: .0 dBd

Received power (at remote)

> -103.0 dBmW
< -103.0 dBmW

Minimum threshold level: -200.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
hub_2	* 120.3	15.00	OM-V	N 37 46 44.20
grp: 2	2600.0000 MHz			W122 27 16.30

KILOMETERS
10 0 10 20 30

TEST RS INTERFERENCE

Equivalent omni-directional hub

Figure 6 971130